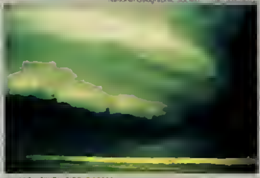
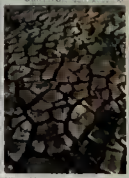
WILDLAND FIRE IN THE NORTHERN ROCKIES

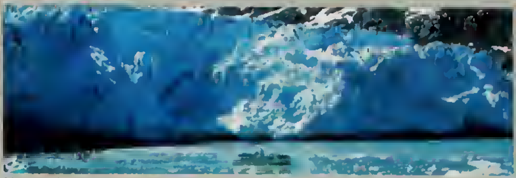
IN THE NATURE OF CHANGE
UNDERSTANDING FIRE'S ROLE IN NATURAL AREAS

Mt St Helens 1980

Johnstown Flood 1889






Glaciation in Alaska today

Fire and humans are ancient partners in shaping our world. Lightning and human-caused fires have been a great force for change in wild country. And, like the life cycles fire creates on natural landscapes, there are cycles of fire wisdom in human culture. At times fire has been an enemy; at times it has been a friend or a tool. But fire can be a treacherous ally, and at times is an unruly servant, prone to rebellion. Even today we are occasionally reminded that fire, like wind, cold, flood, and other natural forces, can be hard on those who try to master it. In primitive societies, fire was a central part of human culture, and as culture became more sophisticated, simple ideas about fire developed into rich religious symbolisms. The Greeks believed fire was a possession of the gods, only reluctantly shared with humans; fire, even then, was seen as a mixed blessing, bringing with it risks and responsibilities as well as gifts. The traditional image of prehistoric societies using fire only to cook and keep warm does not do justice to the resourcefulness of our ancestors. Native Americans, for example had many uses for "Grandfather Fire," from the famous smoke signals to wholesale alterations of landscapes. Indians set fires to prairies knowing that the new growth would attract game. Fire was used to drive game, to scorch an enemy's grazing lands, to reduce populations of unwanted animals, to enhance crop growth, and to clear forests. Fires set near villages protected them from other fires. For many Indians, fire was the foremost agent for changing their world.

Europeans came to North America with an entirely different fire wisdom, based on centuries of intensive land cultivation and permanent habitations. Wildfire and the ecological changes it caused were necessarily seen as evil. As North America was settled, the European fire wisdom allowed for no fire except that completely controlled by humans. Over the past century, we have become steadily more skilled at suppressing unwanted fires. Aerial firefighting technology has enabled professional firefighters to mobilize huge, effective suppression efforts. Only under extraordinary circumstances—such as the extreme drought, high temperatures, low moisture content, and high winds of the Summer of 1988—can fire still run free. But as the wild continent was tamed, a new fire wisdom evolved. Scientific research revealed that the changes caused by fire were not all harmful to human needs. Prehistoric fires created and maintained a diversity of plant and wildlife habitats, renewed and invigorated aging forests, and released nutrients into soils, thus accelerating the succession of vegetation types on the land. Working in concert with other natural forces—periodic floods and droughts, winds and precipitation, and the actions of animals—fire was essential to the existence of many ecosystems. Gradually private businesses and government agencies began experimenting with reintroducing fire to the land in ways that would have been unthinkable only a few years before. What had been simply fire suppression became fire management. The Forest Service began intentionally burning some southern forests in the 1940s to create new, even-age growth of greater commercial value. In the 1950s and 1960s, the National Park Service experimented with controlled burns in Everglades and Sequoia-Kings Canyon national parks, and by the late 1970s a dozen national parks, including Yellowstone, were allowing some fires to burn. In parks and forests preserved for their wilderness values, where the processes of wildness are the only "product" being created, flames were no longer seen as good or bad; they were just in the nature of change.

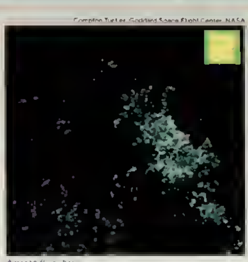
DYNAMICS OF FIRE

The fires of 1988 were a product of global weather patterns. Even huge ecosystems like Yellowstone are just small parts of larger ecosystems. In early 1988, a warming trend in equatorial Pacific Ocean waters (see arrow) caused the westerly jet stream over North America to move north of its usual path. Dry, windy weather resulted, making the region ripe for fire.

Drought Climate changes with the decades as it does with the seasons. The annual growth rings of trees reveal by their varying widths periodic changes in their environment. A series of closely spaced rings reveals a drought; wide rings, a more hospitable climate. Fire scars embedded and healed over, tell us how frequently the forest has burned. Similar records of climatic variation and fire appear in the rings of petrified trees millions of years old (photo at right). Drought, like the fires it encourages, is older than humanity.

Drought years

Yellowstone National Park

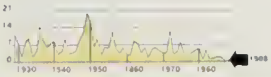

Amazon River Basin

Fires Worldwide More than 4 million acres burned in the West in 1988, but those fires were a relatively small part of a worldwide phenomenon. One fire in May of 1887 burned nearly 3.3 million acres in northern China, destroying more than 10,000 homes in three towns. In 1988 man-caused fires in South America's Amazon basin, shown as bright spots in the satellite image at near left, burned an area many times the size of Yellowstone. See inset for comparison.

An Unexpectedly Dry Summer Despite spring rainfall that far exceeded normal forecasts, summer rainfall fell far short of forecasts in Yellowstone for 1988. This is illustrated by the bar chart at right. The drought index measures both rainfall and soil moisture available to reduce fire danger. The lower the number, the drier the forest. Despite optimistic springtime weather forecasts, the drought index in Yellowstone in 1988 factored out to the lowest figure ever recorded.

Summer 1988 Rainfall

Drought index for Yellowstone



Fire Regimes

Fire Regimes Fires are as diverse as the vegetation they burn. In the chaparral brushlands of California's Santa Monica Mountains (1), the fire interval is 20 to 40 years; the longer the interval, the larger the fire. And fire results in frenzied shows of wildflowers. In Florida's Everglades (2) the fire interval is three to seven years. In the absence of fire, Everglades pinelands succeed to a hardwoods forest type. In the giant sequoia forests of California (3), the fire interval may have been 10 to 20 years, but fire did not kill the big trees. It removed dense undergrowth and enriched the soil for the growth of new giant sequoias. Alaska's Livendorf fire (4) burned 585,000 acres of boreal black spruce forest on land underlain by permafrost. Alaska recorded 2.2 million acres of fires in 1988.

Behavior of Large Fires Given three ingredients—fuel, oxygen and heat—fire moves as conditions dictate. It may creep along the ground consuming only brush and litter with low intensity flames. Or high winds may sweep it into a hot crown fire, consuming entire trees and burning fallen trees to ashes. Embers carried aloft by its in-flames may ignite spot fires miles ahead of the main blaze. This spotting allows a fire to jump major natural and man-made barriers, and it heightens the danger of fighting the fire.

Spotting

Fires typically burn a mosaic pattern as wind-driven flames and spotting create a jigsaw puzzle of green and black patches. This mosaic, with its edges and variety of habitats, is the key to plant and animal diversity.

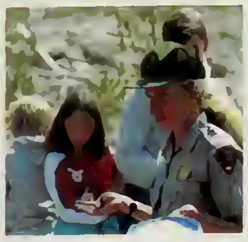
Fighting the Fires Made possible by global conditions, the Yellowstone fires had many local causes. Five of the seven largest started outside the park, the result of lightning or human carelessness. Greater Yellowstone Area fires eventually burned on 1.4 million acres—989,000 in the park—and required the largest firefighting effort in American history. A unified effort by federal (including military), state, county, and city fire crews and many private individuals involved more than 25,000 firefighters, as many as 9,000 at once. About 100 fire engines and dozens of helicopters were recruited from around the country. Firefighters saved almost all buildings in the park, but no existing technology could prevent the fires from making their biggest runs across the wilderness. Greater Yellowstone Area landscapes may in fact heal more quickly from the fires than from effects of fighting them. More than 850 miles of firelines, and hundreds of other disturbances—helipads, campsites, trails—will have to be restored or their scars may last a century or more. Many firefighters worked on this restoration once the fires were controlled.

How Many Animals Died?

	POPULATION	DEATHS IN PARK	DEATHS IN GYA
Elk	32,000	257	345
Bison	2,700	9	9
Deer	2,000	4	36
Black bear	500	2	12
Grizzly bear*	200	0	0
Moose*	6,000	2	12

*Includes adjacent lands **Greater Yellowstone Area

Research Scientists now have a unique opportunity to study fire's effects on an ecosystem-wide basis. How does burning affect the productivity of wildlife ranges? Will ash washed into streams enrich aquatic life? Will grizzly bear movement and food habits change? Will accelerated erosion on steep slopes cause siltation in trout streams? If so, how will effects on the trout be felt by fish-eating bald eagles? The questions, like the park's plants and animals, are all interconnected. There is much to be learned.



Follow These Safe Fire Habits Preventing human-caused fires remains important in or near wildlands. Find out about and follow fire use and safety regulations for the areas you visit. Helping to prevent human-caused fires is everyone's responsibility. Help protect our wildlands with these safe fire precautions.

- Be careful with cigarettes and other smoking materials.
- Build fires only in designated fire containers in developed campgrounds.
- Always put fires out. The way out when not actively tending them.
- In the backcountry and away from developed campgrounds use only self-contained stove units, or comply with local regulations on wood fires.
- Obtain fire permits where they are required and use them in keeping with restrictions.
- Find out about and heed special fire danger conditions and warnings where you travel.
- Make sure that all members of your party, especially children, are fire savvy.
- Report unattended fires to the nearest ranger station.

WILDLAND FIRE IN THE NORTHERN ROCKIES

If, as the saying goes, variety is the spice of life, then fire is the very life of variety. Life in wild settings will go on without fire, but it will be a life crippled and stunted by its own successes. Without the cleansing, culling, and regenerative contributions of fire, a dynamic ecosystem becomes a stagnant garden, piling up dead fuels and choking on its own debris. This is as true for grasslands and brushy country as it is for forests. Only the most arid deserts can maintain diversity without the aid of fire. This is not to suggest that all fire is good. Lack of diversity may be just what is most wanted in a field of grain, a commercial forest, or some other artificially maintained plant community. But where the primary goal is the protection and encouragement of natural processes, then fire must be recognized as a major factor in the fabric of nature, and its influence must either be allowed or imitated. Anyone who has tended a garden or tried to keep a lawn weed-free, knows that nature's tendency toward diversity is relentless. There always seems room for one more species, one more hardy plant or animal colonist looking for a vacant niche. It is that diversity—that spice of variety—that so attracts us to wild places like national parks.

Ironically diversity of life depends most heavily on death; new species get their best starts in an area when old species die. Fire is the great recycler. Life and death are realities in nature, and fire is nature's way of cleaning up the dead so that the living can get on with things. As one fire ecologist put it, "If fire did not exist, nature would have to invent it." Fire's role in a changing ecosystem is elegant in its complexity. When a fire creeps along the understory of a forest, burning ground-covering plants and accumulated litter, it is doing much more than tidying up the forest floor. It is creating heat that may alter the physical or chemical structure of the soil, making it less habitable by some organisms, more habitable by others. It is reducing woody material to ash, thereby releasing forest nutrients into the watershed. It is freeing soil from the bonds of interlacing plants, thereby allowing for increased rain and snowmelt runoff and sedimentation of nearby streams, with resultant changes in the plant and animal communities in those streams. It is exposing soil to more sunlight, making it hospitable to organisms that might not otherwise have been able to colonize the area. If the fire moves from the ground into the trees, it sets off a similar series of changes. By burning the forest canopy, it lets even more light reach the forest floor, again encouraging new plants. Opening the canopy also makes creatures of the forest floor more vulnerable to airborne predators. By creating many new snags, it encourages the nesting of some birds while discouraging the residence of others. By heating and partially burning trees it does not kill, it eliminates many of their parasites, at the same time giving other parasites easier access to the tree through holes burned in the bark. The complexity of this process reveals how nature operates without the orderly sense of direction we humans find so comforting. The forest does not "need" any particular combination of species, any more than it "cares" about diversity. As fire makes soil available for new plant species, it fertilizes the soil for those already present; the new and old will have to struggle for room. And as fire may promote luxuriant growth that feeds one mammal, gradually it may be creating a richer soil that no longer favors that plant or mammal at all. Many things happen at once following a fire, and they do not all take the resulting ecosystem in the same direction.

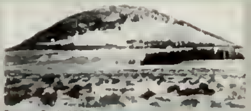
Fires are as individual as the forests they burn. A fire will behave differently from moment to moment, swayed by the flow of wind and the quality of its fuels. A fire will behave differently in forests of different ages just as it will in forests of different species. It will hesitate at a meadow one day, then roar across it as fast as a man can run the next. Fire behavior, like animal behavior, is still partly a mystery to us. But decades of research have shown us what usually happens following a fire, and that process is summarized below, using a Yellowstone forest as an example. Decades of research have taught us that fire is not the end of the forest; it is instead a massive jolt to the forest's living systems, and just the beginning of a new stage in the life of a wilderness.

FIRE IN THE FOREST CYCLE

SOME EFFECTS OF FIRE ARE BENEFICIAL

Trees are like people: they come in many sizes, shapes, and shades. Forests are like cities, they have inhabitants of many ages. As centuries of fire maintain a patchwork of forest and meadow they also ensure that several generations of trees will be growing at once. Each generation of trees—a stand of saplings here, a stand of 350-year-old trees there—hosts its own accompanying vegetation and its own animals. As important, each generation of trees behaves differently in fire. The young forest has very little fuel, a fire may rage right to the edge of a young stand of trees and then simply die out for want of material to burn. An old stand may welcome the flames with many fallen trunks and a heavy undergrowth of spruce and fir.

Almost 80 percent of Yellowstone's forests are lodgepole pine, with a fire cycle of 200 to 400 years. But it is not a constant process, with a little of the forest being burned every year. Most years are too wet for really large fires. Most lightning strikes go out in a day, and only a few burn more than 100 acres. But perhaps once a century, extreme drought will create conditions for huge fires, such as occurred in Yellowstone in about 1700, in the mid-1800s, and again in 1988. Thus, though there will always be trees of many ages in the park, there will also be extensive forests in which all the trees are the same age, born from a large fire.



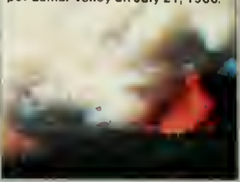
Bunsen Peak, 1897

Bunsen Peak, 1988

Lodgepole Pine Forests Lodgepole pines look like skinny telephone poles topped by Christmas trees. Indians used them in lodge construction, hence their name, and also for litters and drag sleds. One of North America's widest-ranging tree species, lodgepoles grow throughout western North America much as jack pines grow throughout eastern North America. Lodgepoles are especially abundant in the northern Rocky Mountains and the Sierra. Slender, tall, and straight, they often grow on thin soils and in cold temperatures on soils too poor for many other tree species.

Because they can grow in harsh environments, lodgepoles often grow slowly, taking 100 years or more to reach a commercially useful diameter. After a large fire, lodgepole pines can compete successfully with other species for dominance of an area. This trait gives rise to expansive lodgepole forests of even age and size. Lodgepole forests usually live 250 to 400 years, and are most vulnerable to fire at an advanced age.

Yellowstone, 1988



The Clover-Mist fire burns in the upper Lamar Valley on July 21, 1988.

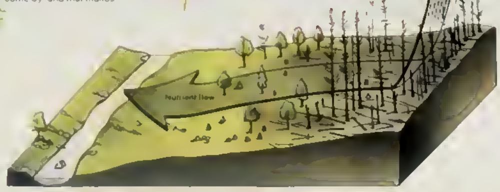
Pine Beetles

Mountain pine beetles bore into pine trees, laying their eggs in the soft layer of cambium. When the eggs hatch, the larvae eat the cambium, often killing the trees, changing their role in future fires.

Fire and Life Fire is a fact of life in the wilderness, and life must adjust. The first adjustment is survival of the fire itself. Animals too small to flee hide in their burrows, and unless the heat is unusually intense most will survive. Birds can simply fly away. Large mammals are rarely trapped by flames. Insects burrow or fly to safety, though many must succumb to the heat. Fish live in the best of all fire shelters, and only in rare cases will the heat be intense enough to hurt them. Plants die in great numbers, their adaptations to fire are aimed at the survival of their descendants. Adjusting to life after the burn is much more complicated than escaping the flames. Small mammals suddenly find their brushy shelter gone, hawks travel great distances to feast on the vulnerable mice, squirrels, and other exposed small mammals.

Burned trees may attract feeding and nesting insects that in turn attract a variety of birds. Lodgepole pine trees drop millions of seeds after a fire, providing further incentive for birds and small mammals to move back into a burn. A sudden heavy rain may wash acidic ash into streams, killing fish, or the minerals in the ash may be released gently, enriching the aquatic systems to the advantage of fish. Animals killed by the fire provide food for scavengers, including eagles, ravens, coyotes, black and grizzly bears, and magpies. Except in a few areas where the soil was heated enough to bake it, the roots, seeds, bulbs, and rhizomes of existing plants will resprout as soon as possible in the freshly fertilized soil. For every death, nature finds life, and gain. Thus the fire has a ripple effect that will continue until the next fire. Practically all the large mammals in Yellowstone survived the 1988 fires, but they will be living with the fire's effects for the next century.

Nutrient Cycle Fire and rain, which seem such opposites, are both essential to the flow of nutrients through the ecosystem. Rain contains some minerals, and dissolves others from rock into the soil. Fire is less frequent than rain, but it acts faster when it comes. Yellowstone's lodgepole pine forests are growing on thinner, younger soil than lodgepole pines in other parts of the West. Nutrients are harder to come by, and that makes fire all the more important in the park. Most mineral nutrients cycle repeatedly through an ecosystem, from soil to plants (and sometimes through animals) and back to soil.



When fires are suppressed, the system breaks down, and the minerals remain locked up in forest litter and dead trees. Fire accelerates the cycle, allowing minerals to be moved by rain back to the soil, enhancing plant growth. Plants are further encouraged by the increased sunlight coming through the open canopy of the burned forest. Fire scars in trees (left) date past fires to establish fire return intervals.

Lodgepole Pine Even in one ecosystem, trees can adopt dramatically different strategies for surviving fire. The lodgepole pine produces some cones that open and release their seeds routinely, and others that do so only when heated by a fire. The fire-opened cones guarantee that the tree will be able to reseed its area following a fire.

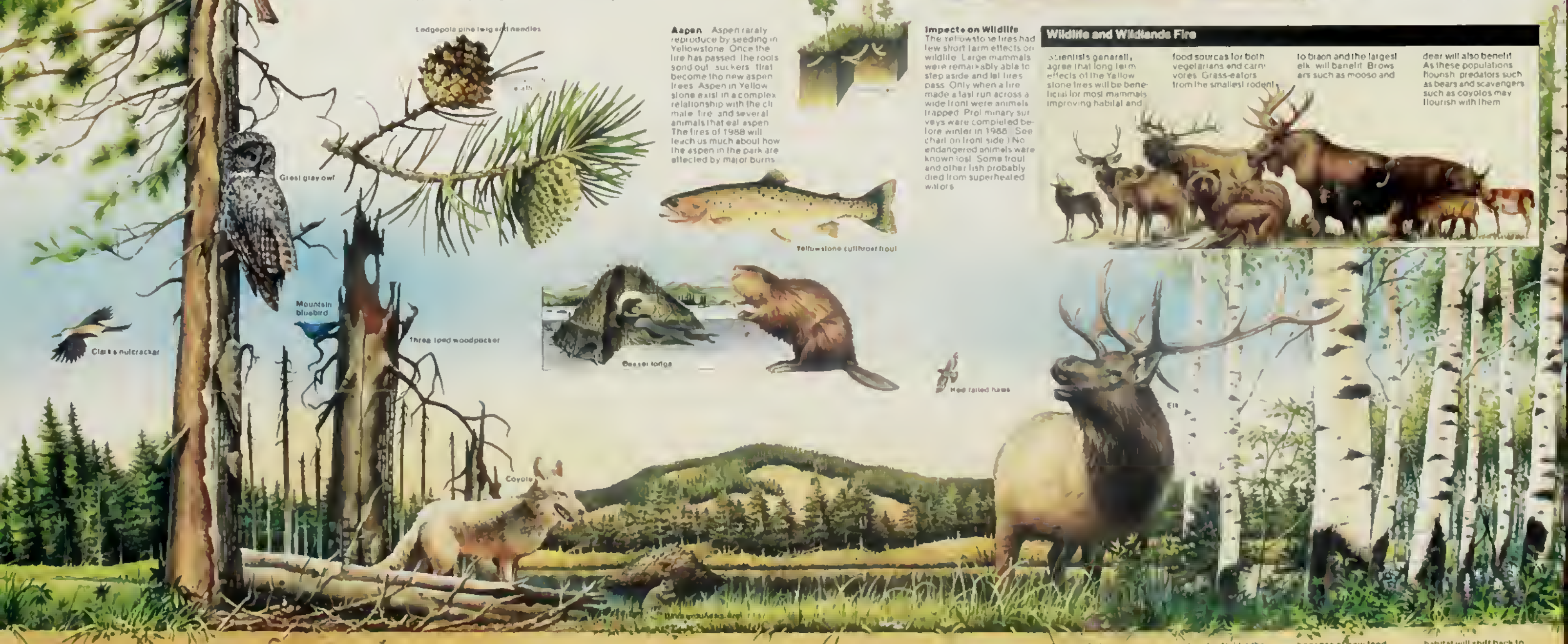
Surveys in 1988 revealed densities of newly released seeds on the forest floor ranging from 50,000 to 1,000,000 seeds per acre.

Aspen Aspen rarely reproduce by seeding in Yellowstone. Once the fire has passed, the roots send out "suckers" that become the new aspen trees. Aspen in Yellowstone exist in a complex relationship with the climate, fire, and several animals that eat aspen. The fires of 1988 will teach us much about how the aspen in the park are affected by major burns.

Impacts on Wildlife The Yellowstone fires had few short-term effects on wildlife. Large mammals were remarkably able to step aside and let fires pass. Only when a fire made a fast run across a wide front were animals trapped. Preliminary surveys were completed before winter in 1988. (See chart on front side.) No endangered animals were known lost. Some trout and other fish probably died from superheated waters.

Wildlife and Wildlands Fire

Scientists generally agree that long-term effects of the Yellowstone fires will be beneficial for most mammals, improving habitat and food sources for both vegetarians and carnivores. Grass-eaters from the smallest rodent to bison and the largest elk will benefit. Browsers such as moose and deer will also benefit. As these populations flourish, predators such as bears and scavengers such as coyotes may flourish with them.



Postfire Succession Old lodgepole pine forests, with their thick canopy and heavy downfall, host relatively few species of plants. Burning opens the forest canopy, letting in sun and starting a new cycle of plant life. Regrowth begins within days of the fire. The first plants are those whose roots and seeds were present before the fire, but they are soon joined by new plants whose seeds are carried in by natural forces.

After three years, most of the forest floor is covered by a heavy growth of fireweed, aster, elk sedge, lupine, and perhaps two dozen other plants, and the first lodgepole pine seedlings appear. After 20 years vegetation on the site may be 10 times as diverse as it was before the fire. Then, as the forest canopy slowly returns over the course of a century, vegetation underneath becomes less dense until the forest once again resembles its prefire condition.

The newly burned forest favors some animals while it discourages others. With the forest canopy burned off, sunlight will enhance both forage and browse. Snag-nesting birds, like the mountain bluebird, will find many new homes, and tree-drilling woodpeckers will encounter a bonanza of new food sources. The newly opened canopy will also improve hunting by a variety of hawks and owls. Gradually the forest will reestablish itself, and the habitat will shift back to favor those animals that can best make a living in the old forest.